

APPENDIX 4-1

LANL Access Control Interlock Standard (Diagram from LANL Standard LS107-01).

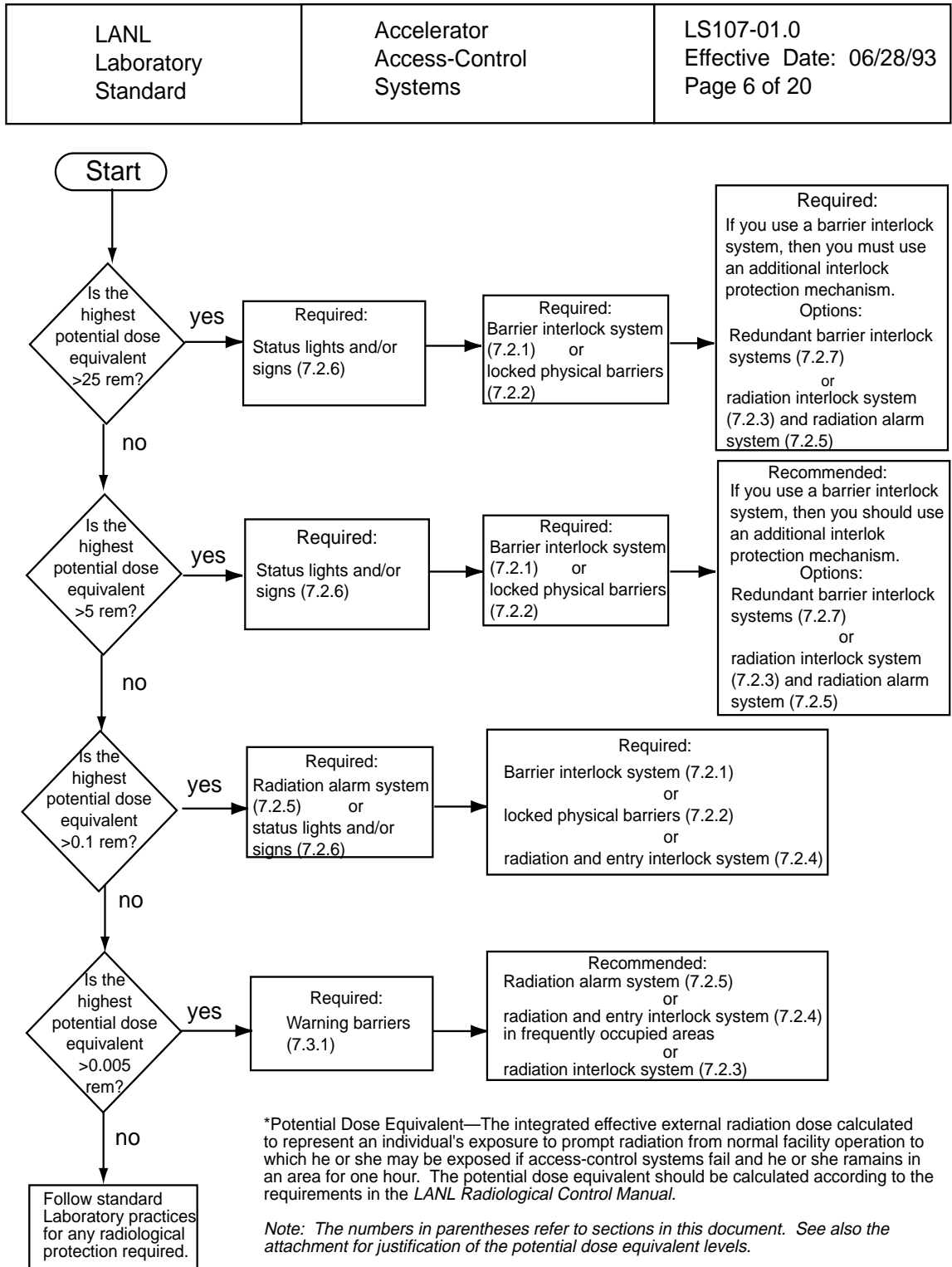


Fig. 1.
Decision Tree for Accelerator Access-Control Systems

January 11, 1996

M. Zumbro

Access Control Principles

The following statement is from the new Prompt Radiation Protection Standard (53FMS-107-01.0 effective 1/1/96):

7.2. Protection from the Design Basis Accident. The shielding shall be configured so that no offsite exposure to a person can exceed 1 rem. Onsite areas which have a potential radiation dose rate exceeding 25 rem per hour in the design basis accident shall have special access controls based upon evaluation and acceptance of the risk by the operating organizations.

To implement the concept, we define the following areas. (Note: Special access controls may apply to the categories of limited access control areas or to open access areas.)

- **Exclusion areas.** Definition: An area with unacceptable hazards during normal operation. (Definition from LS107 -- A radiological area that requires personnel to be excluded by physical barriers with entry-control devices when the potential dose equivalent generated by an accelerator is greater than 0.1 rem.)

These areas are ones where access through normal entry points is prevented and occupancy is prohibited when hazardous conditions exist. Access points are normally controlled with Personnel Safety System (PSS), Personnel Access Control System (PACS - the access control system design that complies with LS107-01.0), keys under strict administrative control, or lockout/tagout. Areas designated as exclusion areas are typically primary and secondary beam areas. Non-prompt high and very high radiation areas are included in this category. Areas where access is prevented solely for prompt beam hazards may become open areas when the accelerator is not in operation.

- **Limited access control areas.** Definition: An area with acceptable hazards during normal operations for workers having site-specific training, but which may be hazardous in excess of 53FMS-107-01.0 requirements under abnormal conditions.

These areas are ones where access through normal entry points is controlled with no general access to the areas. In these areas, the hazard exists only under accident conditions. Access to the areas and appropriate restrictions may be approved by the TA-53 Landlord, normally following Radiation Safety Committee evaluation and recommendation on the level of risk presented by access. Access and occupancy may be prohibited at the discretion of the Accelerator Operations Group during non-standard beam conditions.

An example of control might be badge-reader access only with appropriate radiation worker and area-specific training. A requirement may be audible alarms for radiation (such as albatrosses) and there may be a requirement for Radiation Security System (RSS) instrumentation protecting the areas (such as beam current limiters and radiation detectors in RSS).

- **Open access areas.** These areas are normally accessible to workers with current site-specific training.

APPENDIX 4-3

Los Alamos
NATIONAL LABORATORY
memorandum*Manuel Lujan, Jr. Neutron Scattering Center**To/MS:* Gary Russell, LANSCE, MS H805*From/MS:* Phil Ferguson, MST-4, MS H805*Phone/FAX:* 7-2072/FAX 5-2676*Symbol:* LANSCE-94-293*Date:* December 15, 1994**SUBJECT: Preliminary Comparison of the LAMPF Beamstop Radionuclide Inventory Calculation with DOE-STD-1027-92 Category 3 Threshold Quantities**

In support of the preparation of the TA-53 Safety Analysis Document, the LANSCE Target Physics Team was asked to calculate the radionuclide inventory for LAMPF target station A-6. Using the LAHET Code System [1], a detailed calculation of nuclide production/destruction and neutron flux was completed. The results were given to Bill Wilson (T-2), who performed the time-dependent nuclide inventory calculations using his code, CINDER'90 [2]. A 1 mA beam of 800 MeV protons were assumed to be incident on the A-6 beamstop. The irradiation history was taken to be 9 months of operation followed by 3 months of shutdown. This schedule was repeated until 5 operating cycles were completed. The data discussed in this memo are for times immediately following the final beam shutdown after the fifth irradiation period. Results in this memo are tentative, as recent improvements to CINDER'90 have not been verified with experimental data. The distribution has been limited until verification has taken place.

Figure 1 shows the total activity in terms of DOE-STD-1027-92 Category 3 Threshold Quantities (TQ's) as a function of time after beam shutdown. The activity for each nuclide was normalized to its Category 3 TQ limit and then the nuclide activities were summed for each region. Category 3 TQ's were used because Category 2 TQ's are not yet available for all nuclides. The total activity is sub-divided to show which components dominate the total activity of the system. From the legend of figure 1, 'H2O cooled steel' refers to the lower portion of the water cooled neutron and proton inserts. 'Depleted U' represents the depleted uranium shield. 'Steel behind IP/n inserts' refers to the lower portion of the solid steel shielding that follows (in radial terms from the beamstop) the neutron and proton inserts. 'IP stringers & targets' refers to the isotope production targets and holders. While the IP targets are included in this calculation for accuracy, the targets are operated for several weeks and then removed. Therefore the operating time frame of 5 years is unrealistic for IP targets and the results should probably be neglected when calculating the total activity for the target station. All other components, including the copper beamstop, are included in 'others.'

Immediately after shutdown, the A-6 target area exceeds the Category 3 TQ limit by a factor of 280. However, the initial half-life for the target station is short (on the order of 2 -3 weeks as seen in figure 1) and the total activity decays rapidly. More than 65% of the target station activity

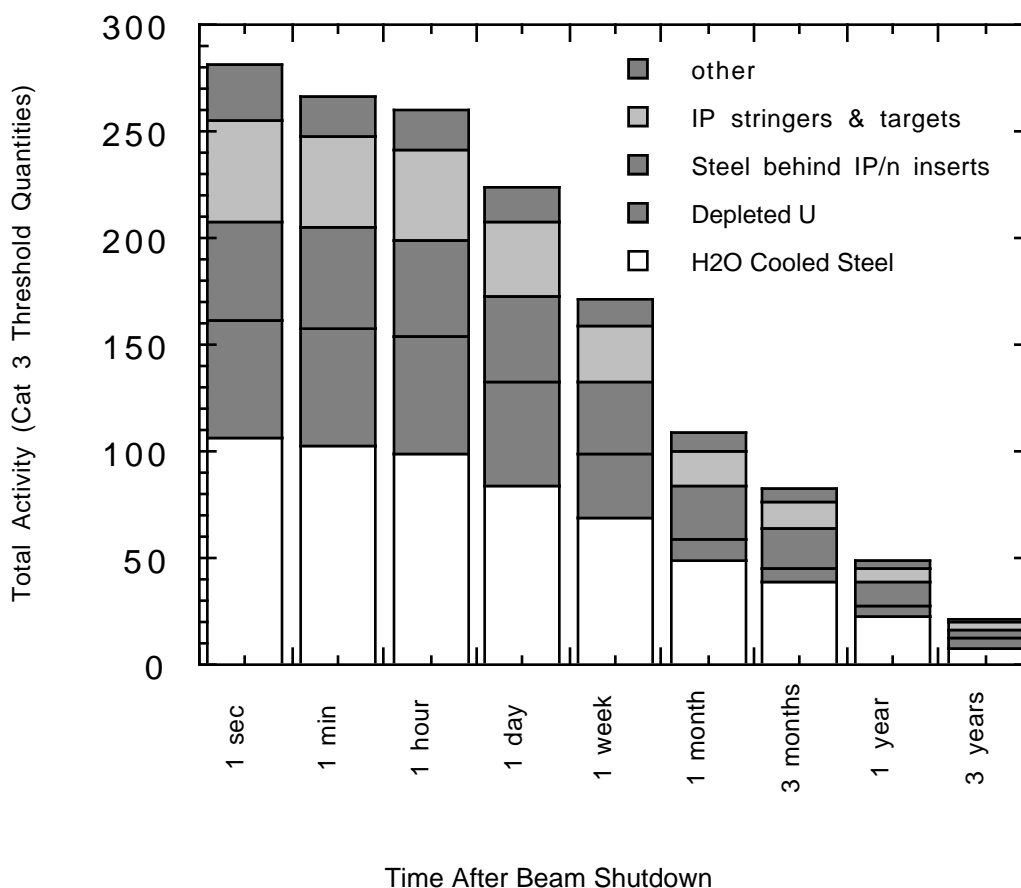


Figure 1. Total Activity for LAMPF Target Station A-6 as a Function of Time After Beam Shutdown

Table 1 lists all isotopes with activities greater than 20% of the Category 3 TQ at 1 second after beam shutdown. The region(s) where the isotope is primarily produced is also indicated. Notable on the list of isotopes in Table 1 are I131, a fission product, Pu239, and Np239, all of which are produced in the depleted uranium shield. From Table 1, the copper beamstop does contribute significantly to the total activity of the system as is seen by the 71.4 kCi of Cu64 produced. However, because the Category 3 TQ value for Cu64 is high, the beamstop does not contribute significantly to the total activity in terms of Category 3 TQ values.

Table 2 lists the radioactive gases that are produce at LAMPF target station A-6 at 1 second after beam shutdown. A large fraction of the Category 3 TQ value from gases can be attributed to

the isotope production (IP) targets. Even if all of the gas from the IP targets is neglected, the TQ value from radioactive gases is approximately 0.2 TQ. Release mechanisms for the gases should be looked at in detail.

Table 1. Radionuclides with Activities Greater Than 20% of the Category 3 Threshold
Quantities at 1 Second After Beam Shutdown

Nuclide	Activity (Ci)	Cat 3 TQ limit (Ci)	TQ Activity	Region(s) of Prominence
Mn 54	50609	880	57.51	steel shielding, steel beamstop
I 131	38.424	0.92	41.77	depleted U
Mn 52	12003	340	35.30	steel shielding, steel beamstop
P 32	408.98999	12	34.08	steel shielding, IP targets
Mn 56	62356	2800	22.27	steel shielding, steel beamstop
Fe 55	74194	5400	13.74	steel shielding
Be 11	15.245	1.36	11.21	H2O degrader/cooled shielding
V 48	4764	640	7.44	steel shielding
Na 22	1447.09998	240	6.03	IP targets
Na 24	1600.40002	300	5.33	IP targets
Pu239	2.0095	0.52	3.86	depleted U
Co 56	802.94	220	3.65	steel shielding, IP targets
Sc 46	1310.90002	360	3.64	steel shielding
C 15	14.274	4	3.57	steel shielding, IP targets
I 133	67.262	19.4	3.47	depleted U
Fe 59	1941.19995	600	3.24	steel shielding
Np239	18700	7800	2.40	depleted U
Y 88	473.45999	280	1.69	IP targets
S 35	119.89	78	1.54	IP targets, cooled shielding
U 238	5.2764	4.2	1.26	depleted U
P 33	113.9	94	1.21	IP targets, cooled shielding
In114*	263.85001	220	1.20	IP targets
Nb 90	344.39999	300	1.15	IP targets
In116*	5408.39990	6400	0.85	IP targets
Cr 51	17921	22000	0.81	steel shielding
Sc 48	203.89999	260	0.78	steel shielding
Y 86	347.42999	460	0.76	IP targets
Sc 44	1712	2600	0.66	steel shielding
Rb 83	260.70001	400	0.65	IP targets
Co 60	166.63	280	0.60	Cu beamstop
Cu 64	71444	154000	0.46	Cu beamstop
Cd109	78.978	180	0.44	IP targets
Se 75	133.09	320	0.42	IP targets
Ni 57	245.61	600	0.41	Inconel windows, IP targets
Y 87	374.45999	1000	0.37	IP targets
Ce144	34.551	104	0.33	depleted U
Co 58	255.78	900	0.28	Inconel windows
Nb 96	123.61	440	0.28	IP targets
Co 55	250.44	980	0.26	steel shielding
Nb 95	236.94	960	0.25	IP targets
Br 76	129.06	560	0.23	IP targets
Zr 88	437.42999	1920	0.23	IP targets
Sr 85	315.39999	1440	0.22	IP targets
H 3	3315.30005	16600	0.20	water degrader, IP targets
Sr 90	3.2052	16.4	0.20	depleted U

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Table 2. Radioactive Gas Production at 1 Second After Beam Shutdown

Nuclide	Activity (Ci)	Cat 3 TQ limit (Ci)	TQ Activity	Region(s) of Prominence
Kr 77	91.099	800	0.1139	IP targets, Inconel windows
Xe138	50.495	800	0.0631	depleted U
Kr 88	23.123	400	0.0578	depleted U
Kr 79	156.4900 1	4000	0.0391	IP targets, Inconel windows
Xe135	60.116	2000	0.0301	depleted U
Ar 41	17.207	600	0.0287	steel shielding, IP targets
Kr 87	18.511	1000	0.0185	depleted U
Kr 76	26.992	1800	0.015	IP targets
Xe135*	9.759	1800	0.0054	depleted U
Cl 38	56.383	13800	0.0041	depleted U
Xe133	66.848	20000	0.0033	depleted U
Kr 85*	8.1395	4000	0.002	depleted U
Cl 39	7.6033	9000	0.0008	steel shielding

References

[1] Prael, R. E. and H. Lichtenstein, "Users Guide to LCS: The LAHET Code System,"
LA-UR-89-3014 (1989).

[2] Wilson, W. B., "Activity Study of the LAMPF Beamstop," LANL internal memorandum
T-2-M-4755, December 6, 1994.

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